

Abstract

Speckle of a laser beam is reduced by inserting an anti-speckle apparatus in the beam path to disrupt its spatial coherence while
5 maintaining its temporal coherence. In one embodiment, the anti-speckle apparatus is a phase retarder plate bearing periodic optically-coated regions. Transmission or reflection of the beam through coated and uncoated regions causes an internal phase shift of first beam portions relative to second beam portions, thereby disrupting spatial
10 coherence. Size and thickness of the coated regions can be carefully tailored to meet requirements of stepper and scanner equipment manufacturers for maximum allowable spatial coherence expressed as a minimum permissible number of coherent cells across the beam cross-section. An alternative embodiment of an anti-speckle apparatus is a
15 scattering plate bearing a roughened surface. Transmission or reflection of the beam by the roughened surface disrupts the beam's spatial coherence. The correlation length and/or surface height of structures on the roughened surface of the scattering plate may be adjusted to achieve desired divergency and spatial coherence. A liquid matching
20 medium or solid overcoating may be contacted with the roughened surface to adjust the index of refraction at the interface with the roughened surface. The anti-speckle apparatus may serve to outcouple the laser beam, as well, and a fly eye lens may be positioned after the anti-speckle apparatus.